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REFORMS AND LONG-RUN INPUTS USE EFFICIENCY OF INDIAN AND PAKISTANI COMMERCIAL BANKS

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ABSTRACT

The banking sectors in Pakistan and India were reformed in the 1990s to promote competition and boost output through more efficient use of resources. This study assesses the input usage efficiency of both banking industries during pre- and post-reform periods via data spanning nearly four decades and addresses methodological concerns after applying the order-m frontier. According to the data, rather than operating on the predicted or notional frontier to deliver the specified output level, the average commercial banks in both nations appear to operate beyond the efficiency frontier. Indian banks, both domestic and foreign-owned, seem to use inputs around 30% more efficiently than Pakistani institutions of the same kind. Evidence of resource-use efficiency increases and their maintenance over a longer post-reform period is seen in industries from both nations (15% and 3% for Indian and Pakistani banks, respectively). Indian banks' order efficiency did not significantly alter in the early post-reform period, but it later began to improve and kept improving over a longer period (averaging 5% improvement between 2005 and 2020). Evidence of improvements in Pakistani banks' input use efficiency points to a notable improvement in the first post-reform period (about 12%) and then a longer-term trend (an additional 5% from 2005 to 2020).

Keywords: Efficiency, Productivity, Indian banking, Pakistani banking, Reforms, Banking industry, Order-m estimator

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INTRODUCTION

By utilising the order-m efficiency methodology developed by Cazals et al. (2002), which addresses some methodological issues, this study investigates the operational performance approximated by the technical efficiency of both countries' banks over a very long period (thus allowing banks to adjust in inputs usage in particular which are assumed to be fixed in the shorter period) compared to some other studies that performed such analysis, which consider only the immediate post-reforms period (mainly first 10 years). The post-reform period that is investigated by studies such as Shahzad et al. (2021) suggests an increase in productivity, technical efficiency, and total factor productivity for the sample years (2013–2017). This is supported by other studies, such as those focusing on Islamic banking (Ali et al., 2023) and efficiency and productivity (Zhu et al., 2021; Garg & Gupta, 2020; Ahmad & Khan, 2021). The long-run impact of regulatory changes has hardly been debated. The tools need to be developed more or improved by data availability. This study is designed to investigate the long-run impact of pre- and post-regulatory changes on efficiency gains in both countries.

A sophisticated technique of developed order-m estimator, a reliable regression estimator of generalisation of frontier is used to derive the efficiency gains. Both developing countries have particularly unique financial sector positions closely connected to their industry and services sectors. The sectors were heavily regulated, and their pre- and post-period evaluation needed to be carefully investigated with efficiency gains. The results would help provide long-run insights into the changes introduced during the last four decades. The literature suggests that developing countries usually perform poorly due to over-regulation (Kumbhakar & Sarkar, 2003). However, in these unique cases of two countries, tests of efficiency in post-regulatory changes may provide exciting insights into how these deregulation processes improved their outcome, efficient or otherwise. The meaningful results confirm the loss or gain of efficiency due to these changes. The results would derive exciting insights and comparisons of efficiency gains and losses in pre- and post-liberalisation periods.

Efficiency within the banking sector is critical, particularly in developing economies (Berger & Humphrey, 1997). In the 1980s and 1990s, developing economies undertook extensive reform processes of liberalisation, particularly in the financial and banking sectors[1]. This was due to the developed world's productivity and efficiency gains resulting from its better regulatory environment and the wave of liberalisation of trade, investment and financial sector openness. The deregulation processes have contributed towards efficiency gains, but these gains are subject to the nature and kind of deregulations, which vary between

industries (Berger & Humphrey, 1997). Some studies indicate efficiency decreased after deregulation, as in the case of U. S. Banks (Berger & Mester, 2001; Wheelock & Wilson, 1999). However, Bauer et al. (1993) observe that efficiency does not significantly change in the post-deregulation era. In contrast, several studies suggest a positive effect of reforms on efficiency and productivity (Smith, 1997; Gilbert & Wilson, 1998). Berg et al. (1992) also find that deregulation led to an improvement in the efficiency of Norwegian banking. Zaim (1995) identified a similar trend in Turkish banking.

India and Pakistan are two South Asian[2] countries that introduced banking reforms almost simultaneously in the last decade of the last century. The first wave of reforms comprising deregulation and privatisation was introduced in the early 1990s and the second wave during 1998 to 2003. Broadly speaking, these reforms include a reduction in the required reserve ratio, privatisation of public banks, interest rate deregulation and removing barriers to entry. The banking sector in India had historically been highly regulated, but then gradually, the restrictions were lifted. The banking sector remained in a transitional phase for many years and struggled to reduce the burden of overemployment, non-performing assets, government equity, diversification of risk, prudential regulation, technological changes and increasing trends in mergers and acquisitions (Das & Ghosh, 2006; Shimizu, 2010). Pakistan's banking sector has seen similar various regulatory regimes and structural shifts. It had a nearly perfectly competitive market from the 1960s to the nationalisation of the 1970s. However, nationalisation led to gradual inefficiencies and underachievement in the management of banking (Jaffry et al., 2007; 2013). The country has produced significant regulatory reforms to bring competition and make the banking industry more accountable during its 1990 liberalisation wave of reforms. Many new private banks started operating in 1992 alongside publicly- and foreign-owned banks that offer consumer and mortgage finance lending. Control on setting loans and deposits interest rates had been eased, and branch rationalisation decisions made more on economic merits rather than on the behest of political governments, who often try to seek political rents.

As a result of these reforms, the activity in the financial market in both countries has risen in terms of deposit mobilisation, credit creation, investment in government and private equities, etc. With the new firms' entry into the banking markets, the industry has become more competitive in both countries. Recent literature on efficiency, such as Shukla and Lalwani (2020), suggests that Indian banks are on increasing returns to scale both in size and inefficiency. Singh and Thaker (2020) suggest that large public, private and foreign banks are more profitable and efficient than small and medium. Politically, India remained stable, and economic growth has picked up nicely since the beginning of the

century which could help improve the efficiency of the banking sector. Pakistan, on the other hand, struggled on economic and political fronts with below-par economic progress compared to India alongside frequent changes of governments and worsening law and order situation that could impact economic growth and efficiency of the banking sector significantly. Hence, the need for comparative performance analysis of both countries' banking industries is natural and interesting because, despite the differences in politics and related environment, both countries share significant similarities (economic, social, societal and regulatory) as well as the long border. In addition, both developing countries have particularly unique financial sector positions closely connected to their industry and services sectors.

This study makes several contributions. First, it is not so common to analyse efficiency over a longer time by using a lengthy data set to track the longer-term effects of changes. Thus, the study provides an intriguing comparison of two neighbouring nations that have followed two distinct routes since the turn of the century. Second, the work avoids the potentially significant impact of outliers on efficiency ratings by estimating efficiency scores using state-of-the-art techniques. Third, by segmenting the banks according to their ownership structure, the authors assess efficiency patterns much more comprehensively. The effects of ownership on operations are widely known, and our research makes it evident that varying foreign, domestic, and public ownership affects efficiency scores in terms of pre-, immediate- and long-term efficiencies. Finally, the study's conclusions could be helpful for policymakers who are working on deregulation and privatisation initiatives to have a longer-term view of the long-term benefits of these measures while averting criticism from various interest groups.

HOW REFORMS/PRIVATISATION AFFECT FIRMS' EFFICIENCY AND PRODUCTIVITY – THEORY

Privatisation is a transfer of assets rather than activities to the private sector (OECD, 2009). It is usually undertaken by the SOE by itself, or by the state, either directly transferring the state-owned ownership to private entities or by offering shares on the stock market. The offer of ownership is usually to raise the revenue and capital of SOEs or to enhance efficiency, reduce interventions, increase competition or discipline the market. However, there are arguments against privatising strategic assets such as ports, banks and communication, saving jobs and avoiding the foreign investor repatriation of profits out of the country. The main arguments in favour of privatisation are that a change of ownership would bring efficiency gain, increased competition or a reduction in monopolistic structures. However, the overwhelming evidence suggests incumbents after privatisation retained the dominant competition position or expanded the network

access (Roland, 2008). In developing and transition economies, the debate on privatisation has shifted from the failure of privatisation earlier in the late 80s and 90s (Jomo, 2008), constrained by enabling conditions feasible for privatisation. Therefore, it requires pre-conditions of the existence of regulatory or institutional frameworks. The reforms with specific sequencing of reforms are introduced. The preconditions require the necessary level of regulatory development, functioning of the capital markets and protection of consumers and employees. This led to the debate on the very assumption of the efficiency nature of public enterprises whether or inherently inefficient. Inefficient, in this case, the resource allocation is inefficient and marginal cost conditions are high, therefore, the assets should be transferred to more efficient owners.

Several theoretical approaches explain the process as one such case of the Austrian approach which views competition as a dynamic process of exchange and uncertainty that involves profits and high profits. The competition enhances efficiency and consumer gains. In return high profits increase the market power of shares and profits. Under competition firms expect the entry of new firms into the market to compete. The approach particularly emphasises the protection of property rights and the creation of entrepreneurial culture because the entrepreneur is willing to take risks. Whereas, in neo-classical economics, markets are embedded in formal institutions such as laws regulations and organisation of state and private institutions. Under the school, the objectives pursued by the firm would impact the decisions on prices, output, employment and investment. Neoclassical school suggests that higher prices and lower output increase competition. Through competition, firms achieve technical efficiency and maximise output by achieving the factor inputs and focusing on allocative efficiency. However, the degree of inefficiency varied when (Leibenstein, 1966) questioned whether incorporating technical inefficiency causes inconsistency with the neo-classical approach.

From there, the question of whether publicly owned enterprises are inherently inefficient. Although the authors have used different forms of ownership and competition against the monopolistic firm structure. According to Neoclassical economics, competition will result in efficient outcomes in the market. However, privatisation is directly associated with economic performance, via behavioural changes introduced through policy mechanisms to incentives. The policy evaluation fundamentally concerns whether the alternative incentive structures are going to increase efficiency or not. The principal objective of privatisation includes the increasing gain of economic efficiency. However, the policy instrument is not an ideal tool to pursue the goals of efficiency by reducing the power of unions, expanding the base of ownership, or altering the income distribution of various classes. Pursuing profit goals through lead managers could

increase economic efficiency, but it depends on the trade-off between the profits and distribution goals. Another aspect identified by George Yarrow's market failures and deficiencies in monitoring and controlling public enterprises. It depends upon the level of competition in product markets and the related regulatory environment that the government can control and monitor. It is acceptable that competition and regulations determine performance and ownership. Although public priority is to increase competition and improve the regulatory environment rather than pursue the transfer of productive activities to different ownerships. Literature suggests that preoccupation with the ownership question distracts from the fundamental question of making the markets competitive, reducing the risks of market failures. The available evidence supports, prefers and justifies that private ownership is preferred to public ownership but again if there are significant market failures or firms' market powers extensive government intervention merits. The states' control of monopolies in some cases justified through regulatory agencies' control away from direct bureaucratic control and through anti-trust policies to avoid dormancy of monopolised firms. The structural reforms address such issues to alter the diverse ownership within the framework of competition and regulatory environment before introducing the privatisation process. In the natural monopolies case, it would not be desirable or feasible to introduce product market competition and capital market monitoring for the objective of attempting to produce efficient outcomes. Sometimes, a strong regular measure may result in anti-competitive behaviour with price regulation in monopolistic activities.

The theoretical literature addresses the issues of pricing, competition increasing the investment and divesture of stated-owned firms rather than empirical material to find out the conduct and performance of SOEs. The change of ownership as a policy is a flexible tool of policy instruction. Under state ownership, the pricing, employment, location and other instruments are the domain of public policy whereas the SOEs have a variety of different purposes in developed countries the bulk of activities under the SOEs such as water, energy, transport, health and other communications because of economies of scale and density. In these cases, the absence of state intervention may lead to an inefficient supply of goods and soaring prices for different consumers. The regular mechanism requires addressing the vulnerable low-income groups to protect customers from differences in prices or extracting the monopoly rents and providing subsidised supplies at marginal costs. That is why governments are trying to achieve the redistribution of economic resources to diverse groups. Regulating monopoly or pricing the subsidies from general taxation or the over alternatives might have disadvantages to making public ownership attractive. Public ownership sometimes rescues the family firms and protects the interest groups from bankruptcy or liquidation. Government assistance is always targeted precisely to support the

troubled firms by subsidising and other firms may create rival interests as being affected by these supports. This later factor of discriminatory treatment increases the political cost of ownership.

The research on theoretical aspects of privatisation suggests several features of the firm, transaction costs, property rights, agent-principal theory and analytical tools to compare the performance of the public and private sectors and assess the incentive and managerial behaviours before judging their ownership nature. Another debate is linked to the liberalisation of public utilities, where competition requires a guarantee of lower costs and improved quality in natural monopoly cases.

The debate on privatisation suggests a global consensus that neither of the public and private sectors is universally more efficient or effective or can provide equitable goods and services. The theory of industrial organisation suggests public ownership in case of market failures or the case of natural monopolies because utility services involve economies of scale and fixed costs in an inflation structure. The prices and production policies imposed by the governments are to avoid monopolistic profit maximisation for the sake of social welfare. On the other hand, contract theory suggests the provision of incentives and considers that private ownership as compared to public ownership would deliver better performances if offered incentives. Another theory suggested by Vickers and Yarrow (1991) and Laffont et al. (1993) focuses on the role of capital markets where discipline managers leading to differences in incentives make the difference. Chong and López-de-Silanes (2005) suggest that "Privatization should not be looked at in isolation, its success depends on appropriate deregulation and reregulation of privatized firms, as well as the creation of stable institutions that foster the development of financial resources needed by privatized firms to grow independently from the state." This means having improved regulations, creating conditions for competition, transparency, enforcement authorities, introducing anti-trust regulations and regulating and overseeing the elements of monopolies. However, Clarke et al. (2005) study suggests in cases of bank performance improved after privatisation in most developing countries' cases, but privatisation could be successful and beneficial when privatised total rather than partial.

The theoretical issues and practical problems of privatisation are complex as simple proponents suggested a few decades earlier. Institutional economics developed contract theory and information economics that suggest the costs and benefits of the process, regulation and control changes which redefines the debate. Roland (2008) suggests that public ownership of natural monopolies is not warranted but has advances of private ownership are not also unambiguous.

Under contact theory, contracts, or industrial organisation theory natural monopoly invokes the argument for public ownership because of the leverage of government control over pricing and production decisions for social welfare. On the other hand, the critiques of Laffont et al. (1993) suggest government not regulate private monopolies but create incentive contracts to achieve socially desirable outcomes. While Williamson (1981) and Grossman and Hart (1986) suggest ownership, the structure does not matter if the contracts are beautifully written.

EMPIRICAL EVIDENCE ON THE IMPACT OF REFORMS/ PRIVATISATION ON EFFICIENCY IN THE BANKING INDUSTRY

Our review of the literature on the impact of reforms on banks' efficiency and productivity can be divided into two types. Type 1 is comprised of international literature covering a variety of countries from Europe, Asia, America, Africa and other continents. The second type is literature concerning the Indian and Pakistani banking industries. Internationally, there have been numerous studies explicitly concerned with evaluating the effect of regulatory reform upon banking industry performance (see Battese et al. (2000) [Sweden]; Mendes and Rebelo (1999) [Portugal]; Gilbert and Wilson (1998) [Korea]; Heshmanti (2001) [Sweden]; Canhoto and Dermine (2003) [Portugal]; Bonin et al. (2005) [Nigeria]; Berger and Humphrey (1997) [International]; Bauer et al. (1993) [U.S.]; Humphrey (1993); Berger and Mester (1997; 2003) [U.S.]; Humphrey and Pulley (1997) [U.S.]; Alam (2001) [U.S.]; Berg et al. (1992) [Norway]; Leightner and Lovell (1998) [Thailand]; Kumbhakar et al. (2001) [Spain]), among others mentioned in the introduction of this study. However, in each of these cited cases, the authors have drawn very different conclusions concerning the effect of reform, with some studies concluding that reforms had a negative effect and others concluding no change or an improvement in efficiency/productivity levels. In essence, however, most of the studies we have looked at relating to developing countries, in particular, point toward improvements in efficiency and productivity – with some exceptions. Studies related to the U.S. banking industry have highlighted the critical role played by enhanced business conditions in the post-reform period as a prerequisite for successful implementation and the realisation of desired results.

The first comprehensive study to investigate the initial impact of reforms within the Indian banking industry using a DEA methodology was by Bhattacharyya et al. (1997), who analysed the "early reform period" between 1986 and 1991. Interestingly, this study concludes that efficiency marginally declined during the sample period and that, contrary to general perception, public sector banks were more efficient compared to private and foreign banks. The above conclusion has been shared by several subsequent studies, including Saha

and Ravisankar (2000), who, using a more comprehensive selection of input and output variables as part of a DEA analysis, suggest that public sector Indian banks recorded improvements in efficiency over the period between 1992–1995 and 1996–1999, respectively. However, the latter study shows inconclusive results regarding changes in efficiency levels experienced during the second phase of reform. Some other earlier studies that have used DEA as part of an investigation into productivity levels within the Indian banking sector (see Sathye (2003) and Das and Ghosh (2006)) have largely supported these conclusions whilst also highlighting the sensitivity of efficiency scores in different specifications of inputs and outputs. Shanmugam and Das (2004), and Sensarma (2006) conclude that public sector banks are found to be more productive in the production of outputs such as loans, investments and non-interest income during the sample period and significant improvements were observed in the efficiency of Indian banks over time due to reforms. In the latter study, the failure of large-sized banks and banks with foreign ownership in the post-reform period is also highlighted: both were found to be less cost-efficient, and deregulation was seen to worsen cost efficiency over time.

Since 2010, few other studies have also looked at the impact of reforms and broader policy changes on Indian banking. Badunenko and Kumbhakar (2017) stated that Indian banks in general – and particularly foreign banks operating in the country – experienced technological progress after reforms. Like the study by Bhattacharyya and Pal (2013), larger state-owned banks also managed to improve efficiencies. The study concludes that the first batch of reforms nevertheless appears to have been more effective in improving the conditions that led to subsequent improvement in performance. The study by Casu et al. (2013) also suggests that reforms helped improve the efficiency of Indian banks. The impact on banks of different ownerships is variable, though. Das and Kumbhakar (2012) find significant productivity growth after reforms, which they conclude was attained through both technological progress and efficiency improvement. The studies by Ray and Das (2010) and Rakshit (2023) suggest improvement in the earnings and profitability of Indian banks, and that public-owned banks outperformed the privately-owned banks in this regard. Tzeremes (2015) also found improvement in technical efficiency after reforms; however, this study suggests that state-owned banks could not continue this momentum over a longer period. Recent studies by Gulati (2022) and Kale (2022) confirm the earlier findings and suggest that despite the global financial crisis and bad loan issues, Indian banks have improved, or at minimum, maintained performance. Hence, broadly speaking, except for Sanyal and Shankar (2011), the authors of the above-mentioned studies are of the view that Indian banks have generally done very well and, more importantly, that the impact of reforms has lasted longer.

For Pakistani banking, Di Patti and Hardy (2005) analysed the period between 1981 and 2002. In this instance, the authors analysed the pre- and post-deregulation performances of banks in terms of relative profit and cost efficiency, observing an increase in profit efficiency in the period following the initial round of reform with a corresponding increase in the dispersion of efficiency scores. This increase was more substantial for private domestic banks than for public and foreign banks. The results of a study using a similar methodology by Iimi (2004), based on an analysis of the period between 1998 and 2001, stated that efficiency levels did not improve during this sample period. On the contrary, Ahmad and Burki (2016) found that levels of allocative efficiency in Pakistani banking increased in the post-reform period for state-owned and private banks between 1991 and 2005. This can be attributed to decreased over-utilisation of labour and use of operating costs closer to optimal levels after the deregulation policies. Therefore, the study supports policymakers' efforts to deregulate the Pakistani banking sector and recommends introducing further reforms. Ataullah et al. (2004), suggest that between 1988 and 1998 efficiency improved after 1995 for banks of all ownership types. However, it was also observed that the efficiency of public sector banks declined immediately after the reforms.

Despite this relatively high level of interest, few specific studies have attempted to make comparisons between two powerful countries' banking industries within the sub-continent. Howcroft and Ataullah (2006) analysed the performance of the Indian and Pakistani banking industries between 1992 and 1998, concluding that the banking industries in both countries showed improvement in productivity levels over time (where the biggest productivity improvement was shown to be for foreign and private banks, while public sector banks recorded only a marginal improvement). A study by Jaffry et al. (2007) that estimates the change in technical efficiency following regulatory reform largely concurs with this suggestion where, with a Malmquist Index of total factor productivity and a Tobit regression, technical efficiency was found to increase in the post-reform period. This study also suggests that, over time, variation in total factor productivity between banks decreases. Thus, the reforms were found to have had the desired effect on the banking sector and could be judged to have been successful. Relatively recently, Jaffry et al. (2013) compared efficiency levels across Indian and Pakistani banks from 1985 to 2003. The results suggest that the introduction of banking reforms in these countries has resulted in an immediate decrease in efficiency levels, but an improvement in efficiency was noted towards the end of the observed period.

In summary, the studies mentioned above have either used a relatively shorter post-reform period to make a judgement concerning the long-run impact on the banking firm's performance or the methodologies used suffer from specifications

issues and outliers' problems or are limited due to a smaller sample size. This study addresses these issues and uses four decades of data and literature to evaluate the long-run impact of regulatory reforms and liberalisation/privatisation policies. The coverage of the banks is almost the entire population of commercial banks in both countries, and the methodology used is advanced and does not suffer from issues such as outliers and misspecification of the production and cost functions. The choice of inputs and outputs is comprehensive, and conclusions drawn from the study concerning the long-run impact of reforms can be easily generalised to other developing countries with experience or intention of reforming the financial sector.

METHODOLOGY

In this section, we explain the development and estimation of the order-m estimator to measure efficiency, used in this study. We first describe the free disposal hull (FDH) and simple DEA estimator, by strictly following the notations, conventions, definitions and procedures of Wheelock and Wilson (2008; 2009). Next, we consider the order-m estimator. For simplicity, a banking firm is assumed to use human capital and other resources, such as technology, and physical/financial capital (referred to as inputs (p) in the efficiency literature) to produce outputs (q). Referring to the literature on efficiency calculations, we can define the standard production possibility set as $\boldsymbol{p}^t \equiv \{(x, y)|x.$ This can produce y at time t$\}\subset \mathbb{R}_+^{p+q}$. The actual combination of inputs and outputs at a given moment is represented by input p as $x \in \mathbb{R}_+^p$ and output q quantities as $y \in \mathbb{R}_+^q$, culminating in a feasible combination of output and input at a certain point in time. In a more general context, $\boldsymbol{p}^{t\partial}$ is representative of an upper boundary or a benchmark of the production frontier $\boldsymbol{p}^t$. It is usual to measure distance function according to an assumed direction, such as minimise input or maximise output from some point, say $(x, y) \in \mathbb{R}_+^{p+q}$ to the boundary $\boldsymbol{p}^{t\partial}$. Shephard's (1970) input and output distance functions have the following definitions in this context:

$$\theta\left(x, y|\boldsymbol{p}^t\right) \equiv \sup\left\{\theta > 0|\left(\theta^{-1}x, y\right) \in \boldsymbol{p}^t\right\} \tag{1}$$

$$\lambda\left(x, y|\boldsymbol{p}^t\right) \equiv \inf\{\lambda > 0 \,|\left(x, \lambda^{-1}\right) \in \boldsymbol{p}^t\} \tag{2}$$

The output distance function of Equation (2) measures the distance from the input vector x, and the input distance function of Equation (1) measures the distance (x, y) to $\boldsymbol{p}^{t\partial}$ in the direction orthogonal to the output vector. Using the constant returns to scale (CRS) assumption, the output distance function is the inverse of the input distance function $\theta(x, y|\boldsymbol{p}^t) = (x, y|\boldsymbol{p}^t)^{-1}$. However, in this case, variable rate of return (VRS) can have a negative effect on performance estimates

due to heterogeneity in size of the banking firms. The direction-selection problem was addressed by Färe et al. (1985) and a new method calculated the distance from a fixed point (x, y) to $\boldsymbol{p}^{t\partial}$ on a hyperbolic path as follows:

$$\gamma\left(x, y|\boldsymbol{p}^{t}\right) \equiv \sup\left\{\gamma > 0 \,|\left(\gamma^{-1}x,\ \gamma y\right) \in \boldsymbol{p}^{t}\right\} \tag{3}$$

In this method, the true distance function of production set $\boldsymbol{p}^{t}$ is estimated from a set $\mathcal{sn} = \{x_{\mathrm{i}}, y_i\}_{i=1}^{n}$ of actual output/input combination of a sample banking firm. While estimating, the unknown true $\boldsymbol{p}^{t}$ is characterised by an estimator of the production set to find an estimator of the distance function. Deprins et al. (1984) proposed in this context the free disposal framework (FDH) of the observations in $\mathcal{s}_{nt}^{t}$ as:

$$\tilde{\boldsymbol{p}}\left(\mathcal{S}_{nt}^{t}\right) = \mathrm{U}_{(x_i, y_i)\in\mathcal{S}_{nt}^{t}}\left\{\left(\mathrm{x}, \mathrm{y}\right) \in \mathbb{R}_{+}^{\mathrm{p+q}} |\mathrm{y}\ \leq \mathrm{y}_{\mathrm{i}},\ \mathrm{x} \geq x_{\mathrm{i}}\right\} \tag{4}$$

For simplicity, a commonly used DEA estimator can be obtained by assuming VRS and replacing $\boldsymbol{p}^{t}$ with a convex hull of $\tilde{\boldsymbol{p}}(\boldsymbol{\mathcal{s}_{nt}^{t}})$ as:

$$\widehat{\boldsymbol{p}}_{DEA}^{\boldsymbol{t}}(\mathcal{S}_{nt}^{t}) = \left\{(\mathrm{x}, \mathrm{y}) \in \mathbb{R}_{+}^{\mathrm{p+q}} \middle|\, \mathrm{y} \leq \sum_{\mathrm{i}=1}^{\mathrm{n}} \kappa_{\mathrm{i}}\, \mathrm{y}_{\mathrm{i}}\,, \mathrm{x} \geq \sum_{\mathrm{i}=1}^{\mathrm{n}} \kappa_{\mathrm{i}} \mathrm{x}_{\mathrm{i}}, \sum_{\mathrm{i}=1}^{\mathrm{n}} \kappa_{\mathrm{i}} = 1, \kappa_{\mathrm{i}} \geq 0\ \forall_{\mathrm{i}} = 1, \ldots, \mathrm{n}\right\} \tag{5}$$

The estimator listed above determines the technical efficiency of the sample banking firm at a given moment through a combination of inputs and outputs.

Although the DEA and FDH estimators have made significant progress in determining statistical properties, both suffer from slow convergence rates, arbitrary choices of input/output directions, and the side effects of requiring outlier detection and related solutions. It turns out that both have serious disadvantages, such as a larger number of observations required to obtain accurate efficiency estimates, that seldom exist in empirical settings (i.e., a developing country would have 30 to 40 banks). Although the DEA-based hyperbolic distance function mentioned above avoids the orientation problem, the problems of dimensionality and outliers are still unsolved. Since the beginning of the current century, some studies have developed a new generation of estimators such as "order-m" and "order-α quantile estimator", which exploit the idea of partial boundaries. These include an elaboration of the "order-m" estimator by Cazals et al. (2002) and the development and application of conditional/unconditional "order-α" quantile estimator by Daouia (2003) and Daouia and Simar (2007).

The order-m estimator by Cazals et al. (2002) is a family of nonparametric estimators that do not require convexity assumptions. This estimator deals with high-dimensional input-output problems and is n-root consistent. In addition, the design is based on partial boundary, instead of total boundary, so deviations are unaffected (thus outlier's effects are avoided, to some extent). According to Wheelock and Wilson (2003), one could construct the following distance function with input/output orientation by utilising a random draw of m output vectors subject to given inputs as follows:

$$D\left(x, y | A_m^t\left(x, y\right)\right) \equiv inf\left\{\theta > 0 | \left(x, y / \theta\right) \in A_m^t\left(x, y\right)\right\} \tag{6}$$

For a $\in \mathbb{R}_+^q$, expected maximum potential output/use of the input of order m is worked out in a way that $f_x^t(x) = f^t(x,y)/f^t(y|x) >$, $y_m^{t\partial}(x) \equiv y/\mathrm{E}[D(x, y|A_m^t(x,y))]$, and the order-m substitute of frontier $\boldsymbol{p}^t$ is shown as:

$$\boldsymbol{p}_m^t \equiv \left\{\left(x, y\right) | \left(x, y\right) \in \boldsymbol{p}^t,\ y \leq y_m^{t\partial}\left(x\right)\right\} \tag{7}$$

In this case, the closure of the complement of is called order-m frontier and is defined as. Under this innovative method, for any banking firm, the observed quantity of output/input is compared to what is expected from any m randomly chosen banking firm that does not utilise more quantities of input than the firm being analysed. The maximum/minimum possible output/ input of a given m random firms can be calculated. The developed Monte Carlo method of Cazals et al. (2002) can be utilised and performance parameters can now be measured. Empirical studies that use this estimator, such as Wheelock and Wilson (2004), have suggested values from five to hundreds or more to select values for the cut-off parameter m. In this study, we obtained order-m efficiency estimates in the input direction using m = 5, 10, 25 and 50.

DATA

We split the analysis into two sections by the paper's goal, which is to look at how reforms affect efficiency. The first section evaluates and analyses data (7 years) before and during the first 10 years after reforms. The data for the next time frame spans from 2005 to 2023, to observe longer-term effects. The years 2004 for both nations and 2021–2023 for Pakistan are excluded for various reasons of data unavailability. An unbalanced panel data sample of 73 Indian and 41 Pakistani banks for the period 1985–2003 and 55 Pakistani and 106 Indian banking firms for 2005–2023 is used to calculate the input-oriented efficiency scores. From 1985 to 2003 period, 41 Pakistani banks are comprised of 6 public, 16 private and 19 foreign-owned banks. For India, these numbers are 23 private,

23 foreign and 27 public-owned banks. For the period 2005 to 2023, in terms of distribution of the ownerships, 55 Pakistani banks are comprised of 9 public, 22 private and 24 foreign-owned banks. The 106 Indian banks are comprised of 27 public, 30 private and 49 foreign-owned banks. The data is assembled from multiple sources including individual bank's annual reports, Bankscope and central banks of both countries. Concerning the selection of inputs and outputs, we followed the literature in this regard and then tested the robustness of our estimates and related conclusions through a sensitivity analysis exercise. Table 4 contains details of the base model, where inputs include several employees, fixed assets and capital and reserves, and outputs are comprised of loans, investments, time deposits, saving deposits, current deposits and several branches, as well as three alternative models with a variety of inputs and output variables. The large coverage period and the whole industry datasets are enough to capture the efficiency level in both the pre- and post-reforms scenarios to determine the nature of changes and the necessary efficiency levels, nonetheless.

RESULTS AND DISCUSSIONS

We divide the analysis of the impact of reforms into two sub-periods. The first 10 years (1993 to 2003) is an initial impact of reforms in two countries, compared to the 1985 to 1991 pre-reforms period. Then a matured and longer-run impact is analysed by considering the period of 2005 to 2020 for Pakistan and 2005 to 2023 for India. Compared to India, the last three years (2021–2023) for Pakistani banking, have been dropped due to the unavailability of comparable data on inputs and outputs. The main purpose of dividing these post-reform periods into two is to observe whether the gains in efficiencies (if any) were long-lasting or temporary. More importantly, the long-lasting impact of reforms would indicate that changes in broader regulatory regimes, and liberalisation of economy and privatisation resulting in new privately-owned banking firms' entry, compelled management to introduce some serious structural changes into operations that would lead to efficiency gains over a comparatively longer period. As highlighted before, this sort of exercise is not common in the literature.

Initial Impact of Reforms and Change of Ownership on Banks' Inputs Use Efficiency

We start our analysis by presenting standard input distance efficiency estimates of the DEA estimator and subsequently present more advanced order-m estimates. We estimate the input distance for each year for the population of banks in India and Pakistan. Because we estimated the efficiency by using each specific year's

input and output rather than pooling the data, we, in effect, estimated the frontier for each year and compared other banking firms against the frontier as described in the methodology section. Figure 1 plots traditional DEA input distance function estimates for Indian and Pakistani banking industries. DEA estimates greater than 1 imply inefficiency in the use of inputs compared to frontier banking firm(s), and hence larger efficiency score estimates or increasing scores over time are indications of rising inefficiency levels in the use of inputs (in this case, as well as estimates of order-m estimators throughout this section). An inspection of trends reveals that, on average, Indian banking firms became more efficient after 1998. For Pakistani banks, however, improvement after reforms appears to not happen outside of 1997–1998 and 2001. Overutilisation of inputs used after the second generation of reforms seems to be around 40% for Indian and more than 50% for Pakistani banking industries. These findings can be seriously misleading due to the issues raised in our previous sections regarding simple DEA estimators that are greatly impacted by outliers and dimension issues (fewer decision-making units against inputs/output space). Hence, we move to our main estimator (order-m) and related efficacy estimates in the following paragraphs.

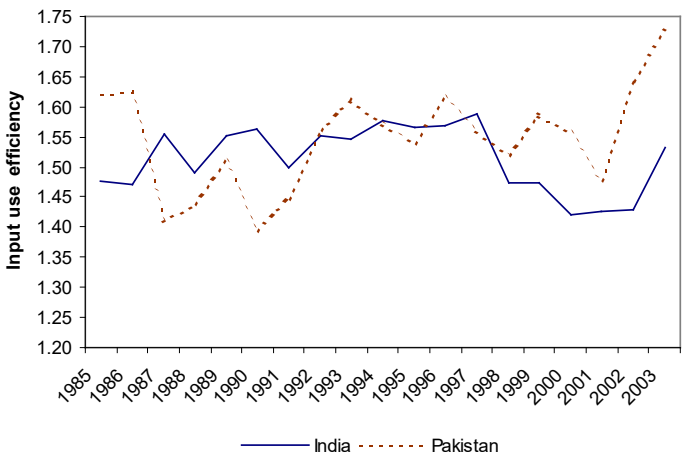

Figure 1: Traditional DEA input distance estimates

Table 1 displays the input-orientated efficiency estimates for Indian and Pakistani banks using an order-m (m = 10) efficiency frontier. These efficiency scores are also provided as geometric (geo) means, median and arithmetic (arth.) mean values for each year between 1985 and 2003 (Figure 2). Results are also provided as averages over different periods so that comparisons can be made between overall efficiency in both pre-and post-reform periods. Comparisons are therefore drawn between the Indian and Pakistani banking sectors before and after 1992 (representing the first round of major reforms) and 1998 (where a second

subsequent round of measures was introduced by both governments to modernise the banking sectors further).

Table 1
Order-m input-oriented efficiency estimates (m = 10)

Periods	India			Pakistan		
	Arithmetic mean	Median	Geometric mean	Arithmetic mean	Median	Geometric mean
1985–1991	0.596	0.582	0.535	0.888	0.917	0.880
1992–2003	0.598	0.592	0.548	0.778	0.834	0.755
1992–1997	0.581	0.582	0.531	0.780	0.838	0.757
1998–2003	0.616	0.603	0.566	0.777	0.830	0.752
1985–2003	0.597	0.589	0.543	0.819	0.864	0.801

The figures displayed are an indication of the usage of inputs as compared to the expected minimum amount dictated by the order-m frontier. Hence deviations from the minimum frontier (given the focus of banking firms on minimising the use of inputs, subject to outputs level) are considered when estimated scores are less than or more than a benchmarked number, which is one. Note, firstly, that all values for all years are less than one, which means that throughout the period analysed, Indian and Pakistani banks used lower quantities of inputs than would be expected by the order-m frontier. Input distance function efficiency estimates that are less than unity in our case is similar to Wheelock and Wilson (2004) using a similar methodology for the US sample.

In terms of a comparison between grouped periods, the separation around 1992 reveals little change in efficiency after reforms for the Indian banking industry but a significant increase for the Pakistani banking industry (around 12% reduction in input use considering geometric mean). The geometric mean estimation for the Indian banks shows a very slight decline in efficiency post-1992 (as the average Indian bank is operating marginally further beyond the efficiency frontier – around 1%), as is shown by the mean and median values. The balance here seems to be almost neutral between measurements, indicating a seemingly neutral initial effect of the banking reforms upon efficiency. All three mean estimates, however, show again a marginal reduction in efficiency post-1998. Regarding Pakistani banking, efficiency scores from 1998 to 2003 are almost like 1992–1997. It appears that the role of reforms in promoting efficiency is more pronounced in the immediate post-reform period for Pakistan. All three means estimate indicates a significant improvement in the efficient use of inputs immediately after the first generation of reforms and at least continued so subsequently.

Historically, Indian banks performed better than Pakistani banks due to their technological advantages. In addition to this, India has the quality of human resources such as graduates from universities like the Indian Institute of Management (IIM), Indian banks also have stronger IT infrastructure. They also have a larger market to serve, which makes it easier to achieve economies of scale. Before reforms, Indian banks were over 35% more efficient at using inputs than their Pakistani counterparts in comparison to the two countries. This disparity decreased to 21% following revisions in regulations and change of ownership. There are two possible interpretations of this. First, Pakistani banks performed better and decreased inefficiencies, which helped to close the gap between Indian and Pakistani banks. As a result, Indian banks did not react to the regulatory framework change. The second explanation is that Indian banks were already in a stronger position, therefore the margin of improvement in lowering the use of inputs was comparatively small. The crucial conclusion is that at the very least, changes did not result in a decline in Indian banks' input use efficiency, nonetheless.

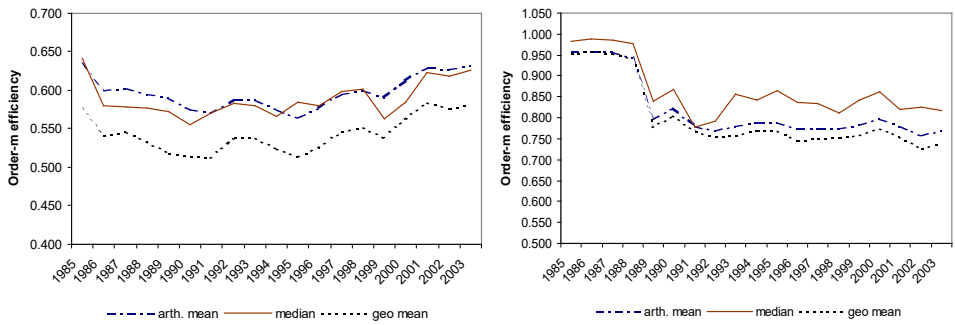

Figure 2: Order-m input-oriented efficiency estimates. (a) Indian banking industry; (b) Pakistani banking industry (m = 10).

Figure 2 represents the information from Table 1 graphically. All three mean estimates seem to follow a similar pattern over time. In terms of observable trends, Indian banks saw an improvement in overall input use efficiency in the 4 years leading up to 1992, but immediately afterward saw a marginal reduction in input use efficiency. The median value is relatively more erratic than both the simple arithmetic means and geometric mean indicators, but it otherwise appears aside that input use efficiency in Indian banks between 1987 and 2003 was relatively stable over the entire period (with values around 0.55 to 0.60). As far as Pakistani banking is concerned, contrary to Indian banking of marginal improvement, input use efficiency improved significantly between 1989 and 1990. This is the period when the homework started to deregulate the market and there was a significant

change in political stance in Pakistan (the first democratic government in 1988 after 11 years of dictatorship). The second round of reforms also yielded a positive change in terms of input use efficiency, as it helped stabilise the comparatively lower scores (thus improvement in efficiency). Broadly speaking, contrary to Indian banks, Pakistani banks appear to respond well to reforms, but trend values of efficiency estimates appear to be better (0.55–0.60) for the Indian banks, compared to the range of 0.75 to 0.80 for the Pakistani banks, indicating relatively more efficient use of inputs by the Indian banks (around 20%). More importantly, reforms appear to have helped Pakistani banks to catch up with banks in neighbouring countries in terms of better utilisation of resources at their disposal.

Next, we performed some sensitivity analysis by choosing different orders of the frontier. Table 2 displays geometric mean efficiency measures against the order-m frontier with differing order (values) of m used to construct the sample of banks producing outputs level by a combination of different inputs from which the frontier is constructed. It should be noted that, as the m increases from 5 to 50, the input use efficiency score of the average Indian and Pakistani bank appears to get closer to the frontier (a score of 1), representing declining levels of efficiency. However, it should also be noted that the values in all years and for all levels of (m) remain less than 1, indicating that Indian and Pakistani banks operate beyond the order-m efficiency frontier. When the frontier is constructed to order 5, it appears that Indian and Pakistani banks are operating some considerable distance beyond the frontier and are displaying considerable efficiency in the utilisation of inputs. As the order of the efficiency frontier increases, that efficiency seems to decrease, although it remains beyond the frontier. This is the case until order 50, at which the average Indian and Pakistani bank operates quite close to, but still beyond, the efficiency frontier. Similar to the findings of Di Patti and Hardy (2005), Ahmad and Burki (2016), and Ataullah et al. (2004), at all orders of (m), the results indicate that the 1992 reforms had a positive effect on the efficiency of Pakistani banks. Interestingly, all orders of (m) used to calculate the geometric mean efficiency levels for Indian banks did not show a reduction in efficiency (increase in score) for the 1998 reforms whilst for Pakistan both the first and second generation of reforms appear to have had the same positive effect on the efficient usage of inputs. The efficiency scores for the Pakistani banks during 1992–1997 and 1998–2003 appear to be though not significantly different, irrespective of the order of m chosen.

Table 2
Order-m input-oriented efficiency estimates (geometric means with m = 5, 10, 25 and 50)

Periods	India				Pakistan			
	orderm5	orderm10	orderm25	orderm50	orderm5	orderm10	orderm25	orderm50
1985–1991	0.382	0.535	0.748	0.891	0.609	0.880	0.951	0.992
1992–2003	0.402	0.548	0.757	0.889	0.574	0.755	0.921	0.978
1992–1997	0.384	0.531	0.746	0.883	0.578	0.757	0.922	0.979
1998–2003	0.420	0.566	0.767	0.895	0.571	0.752	0.920	0.978
1985–2003	0.395	0..543	0.754	0.889	0.587	0.801	0.932	0.984

Figure 3 displays the information from Table 2 graphically. The graphs show that the relative efficiency measures are pulled back closer to the frontier as we increase the order of (m) from 5 to 50 for Indian and Pakistani banking. It is also possible to see that efficiency estimates seem to fluctuate slightly less over time as the order of the frontier increases, with the order 50 estimations being more stable than those at order 5. We can also see a non-significant change in efficiency for Indian banking, which is not in line with Ray and Das (2010), Das and Kumbhakar (2012), and Sanyal and Shankar (2011). However, this is like Bhattacharyya and Pal (2013) who concluded that initial positive effects disappeared and later reforms negatively impacted performance. This is consistent with the explanation above, which describes the relative success or failure of the 1992 and 1998 reforms in terms of changes to observable efficiency levels. For banks in Pakistan, since 1989, efficiency seems to have improved in the post-reform period. Hence, irrespective of the choice of m value, changes in the prudential regulations and broader reforms have a positive impact on the Pakistani banking industry but then again as discussed before, perhaps margin for improvement existed more for the Pakistani banks.

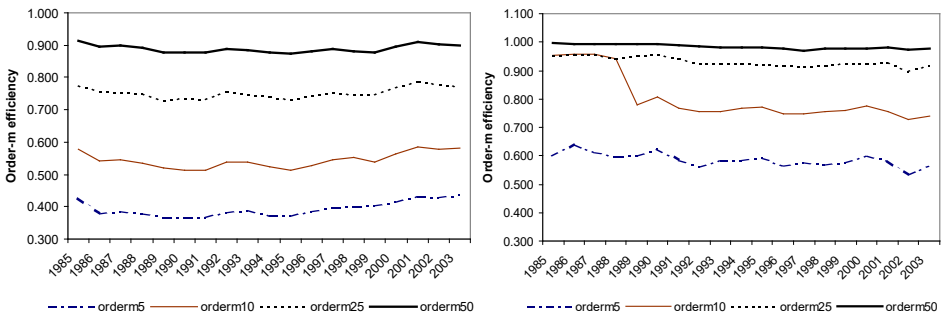

Figure 3: Order-m input-oriented efficiency estimates (geometric means). (a) Indian banking industry; (b) Pakistani banking industry.

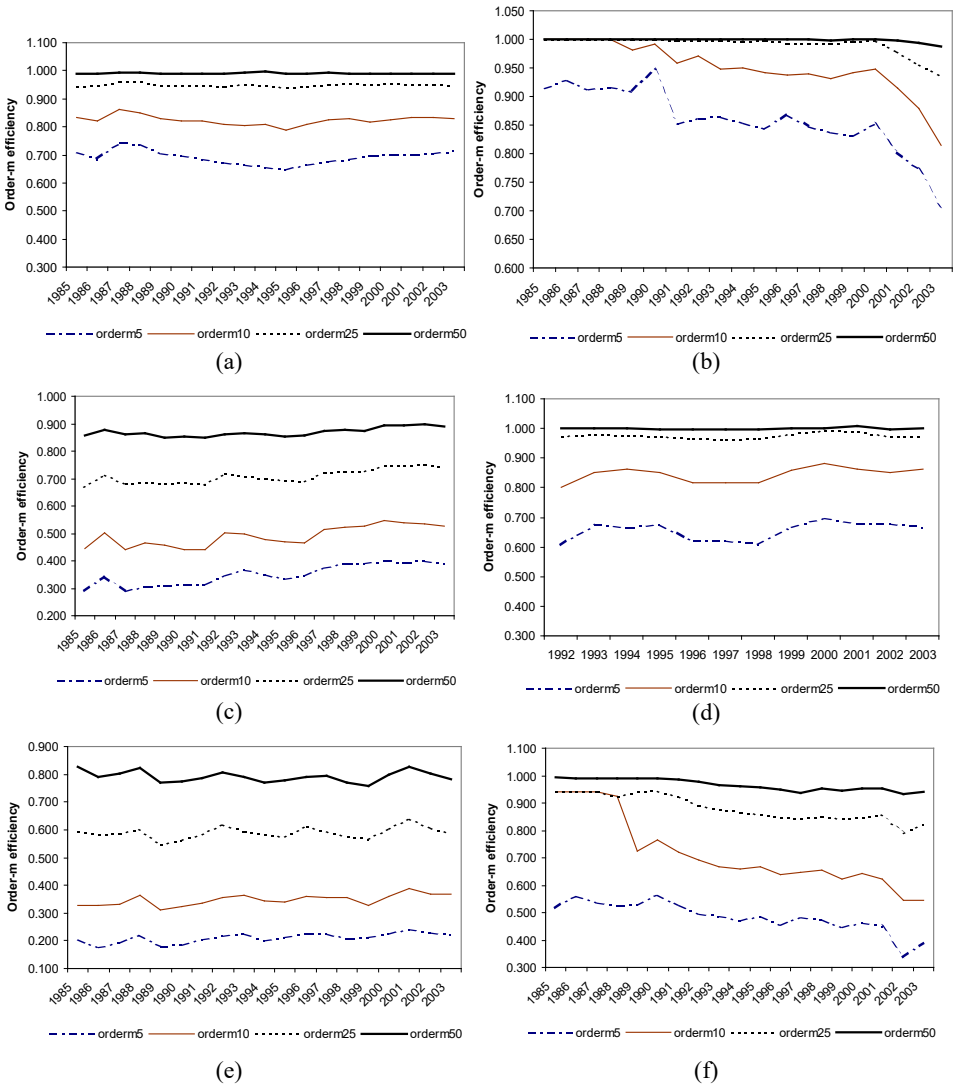

Figure 4: Input-oriented efficiency estimates by ownership types. (a) Indian public banks; (b) Pakistani public banks; (c) Indian private banks; (d) Pakistani private banks; (e) Indian foreign banks; (f) Pakistani foreign banks.

Finally, Figure 4 and Table 3 indicate differences in order-m input efficiency estimates from three types of bank ownership in India and Pakistan: public, private and foreign. The immediate observable trend is that irrespective of the country, foreign banks consistently operate farthest beyond the efficiency frontier and display the highest levels of input use efficiency across the entire

initial impact period under consideration. This is not an unexpected finding, as these groups of firms are not burdened to shoulder higher employment levels in the sector compared to public-owned banks with excessive employment. These banks also source technology from the parent organisation alongside more budget for technology and training facilities. Foreign banks are followed quite closely by privately owned banks, which display the next highest levels of efficiency. Contrary to the findings of Ray and Das (2010), Bhattacharyya and Pal (2013) and Das and Kumbhakar (2012), public sector banks appear considerably less efficient in inputs usage than the other two types of ownership between 1985 and 2003, operating much closer to the efficiency frontier (more so for the Pakistani banks).

Table 3
Order-m input-oriented efficiency estimates by ownerships

Periods	India				Pakistan			
	orderm5	orderm10	orderm25	orderm50	orderm5	orderm10	orderm25	orderm50
Publicly owned banks								
1985–1991	0.710	0.834	0.951	0.990	0.911	0.990	1.000	1.000
1992–2003	0.683	0.818	0.950	0.991	0.829	0.926	0.986	0.998
1992–1997	0.665	0.807	0.947	0.992	0.857	0.948	0.996	1.000
1998–2003	0.701	0.828	0.952	0.990	0.800	0.904	0.976	0.997
1985–2003	0.693	0.824	0.950	0.990	0.859	0.950	0.991	0.999
Privately owned banks								
1985–1991	0.310	0.457	0.685	0.859				
1992–2003	0.375	0.511	0.723	0.875	0.656	0.845	0.976	0.999
1992–1997	0.354	0.489	0.706	0.862	0.644	0.834	0.973	0.998
1998–2003	0.396	0.533	0.739	0.888	0.667	0.855	0.980	1.000
1985–2003	0.351	0.491	0.709	0.869				
Foreign-owned banks								
1985–1991	0.196	0.332	0.580	0.797	0.537	0.851	0.936	0.990
1992–2003	0.221	0.357	0.596	0.789	0.454	0.634	0.850	0.952
1992–1997	0.218	0.353	0.596	0.788	0.480	0.662	0.864	0.958
1998–2003	0.224	0.361	0.596	0.789	0.428	0.606	0.835	0.946
1985–2003	0.212	0.347	0.590	0.792	0.485	0.714	0.882	0.966

When evaluating the pre- and post-reform periods for Indian banking, public sector banks managed to improve input use efficiency by 1% to 3% between 1992 and 2003 when considering orders m of 5 and 10. In contrast, private sector banks experienced a decline of more than 5% after reforms. For foreign-owned banking firms, this decline is a mere 2% to 3% during the first and second rounds of reforms. The variable response to reforms by different types of banks is like

Casu et al. (2013), who also suggested heterogeneous responses by different ownership banks. Thus, the drop in efficiency of privately held banks (both domestic and private) might be linked to the improvement in public-owned banks, which would lead to the industry trend of no substantial change above. On the other hand, if one compares the three ownerships, privately owned banks already functioned at a much higher level of efficiency than public-owned banks, and there was perhaps less room for improvement. More significantly, however, reforms forced public sector banks to make improvements, albeit slight ones in this instance.

For orders 5 and 10 estimates in the case of the Pakistani banking industry, public sector banks improved performance in input usage from 1989 onward. More specifically, public sector banks experienced an efficiency improvement of more than 5%. On the contrary, privately-owned banks did not see any significant change in the way they performed in the early and mid-1990s (improving by a mere 1% to 2% only during 1998–2003 but losing gains in subsequent periods). Foreign banks – like public sector banks – also experienced substantial improvements in efficiency in the post-reform era. More importantly, foreign banks' efficiency score increased by 7% to 20% (the most significant change happening between 1998 and 2003) with greater variation in efficiency score when order-m 5 or 10 are chosen. Again, as stated before, better human and technological resources at their disposal perhaps contributed to this significant improvement in input usage efficiencies. More, importantly, the overall improvement in efficiency for the entire industry appears to be as result of public and foreign-owned banks improving after reforms.

A further comparison across both countries shows that Indian banks on average seem to be more efficient in the use of inputs as compared to Pakistani banks, irrespective of ownership type. Hence, a significant positive change for Pakistani banks after reforms is not surprising given the fact that these banks have higher scope to improve (as discussed before), as the difference between frontier banks and those with weak performance was significantly higher. Even after reforms in both countries, the gap between strong and weak performers seems to be higher in the Pakistani banking industry compared to India. Furthermore, during the initial 10 years of the post-reform period, the input use efficiency of Indian banks is almost 20% higher than Pakistani banks. Pakistani banks after reforms improved efficiency, reducing the gap to 20% between 1992 and 2003, compared to 34% during 1985–1990. Public sector banks operated at the less

efficiency level at the end of the century in both countries, and significant input use efficiency difference seems to have been recorded among private and foreign banks of the two countries. In the next subsection, we observe and comment on what happened in the following 19 years.

Sensitivity Analysis

Before we evaluate the longer-run impact of reforms on the performance of the banking industries in India and Pakistan, we carried out a further sensitivity analysis to check the robustness of our estimates. We introduced three variations (named as model 1, model 2 and model 3) to our base model in relation to the choice of inputs and outputs (see Table 4 for details).

Table 4
Sensitivity analysis

Base model	Model 1	Model 2	Model 3
Inputs	Inputs	Inputs	Inputs
Number of employees	Number of employees	Number of employees	Number of employees
Fixed assets	Fixed assets	Fixed assets	Time deposits
Capital and reserves			Saving deposits
			Current deposits
			Number of branches
Outputs	Outputs	Outputs	Outputs
Loans	Loans	Loans	Loans
Investments	Investment	Investment	Investment
Time deposits		Time deposits	
Saving deposits		Saving deposits	
Current deposits		Current deposits	
Number of branches			

In Model 1, we dropped capital and reserves as inputs and kept only two outputs, namely, loans and investment. In Model 2, we used the same inputs but added deposits (three categories) as output, while in Model 3, we dropped capital and reserves and fixed assets and added three types of deposits as inputs. Loans and investments again were kept as outputs. Our sensitivity estimates almost tell the

same story (Figure 5). For Indian banking, since 1989, efficiency increased as per Model 1, but Model 2 and Model 3 results are like our base model. Hence, the exclusion of branches as outputs and capital and reserves as inputs appear to have significant effects on the ranking of efficiency. As far as Pakistani banking is concerned, all three models' estimates appear to indicate that bank management has used the resources more efficiently in the post-reform period. Broadly speaking, Models 1 and 2, appears to have convincing results when it comes to post-reform improvements in input use efficiency (after ignoring the few spikes during different post reform periods).

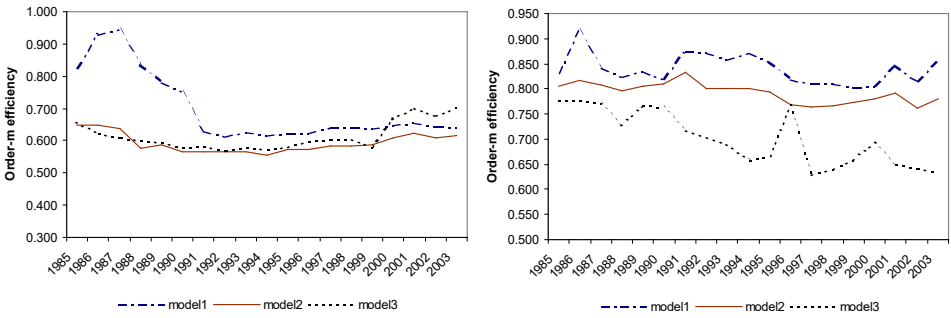

Figure 5: Sensitivity analysis and efficiency estimates. (a) Indian banks; (b) Pakistan banks.

What Happened in The Next Two Decades? Evaluation of Longer Run Impact of Reforms

Indian banking industry

The broader conclusion from the efficiency estimates presented above to Indian banking is that Indian banks experienced no significant improvement in input use efficiency between 1992 and 2003 (covering the initial impact period). It appears that this trend of stagnant efficiency scores did not continue subsequently. The estimates contained in Table 5, when compared to Figure 3a and Table 2, clearly indicate that irrespective of the order of the m, scores are 3% to 5% lower during a more mature period of reforms, thus indicating improvement in input use efficiency. This finding is in fact in line with Tzeremes (2015), Gulati (2022), Kale (2022), and Rakshit (2023) as discussed in the literature review section. More specifically, average order-m5 efficiency estimates were around 0.40 from 1985 to 2003, which declined to 0.36 subsequently from 2005 to 2023 (leading to 4% increase in efficiency). For order-m10, the efficiency scores were around 0.54, which declined gradually to 0.50 during 2005–2023, registering an improvement of 4% in input use efficiency, and concerning order-m25, efficiency score estimates during 1985–2003 were 0.75, which reduced to around 0.72 later, indicating an

improvement of 3%. Even when considering the extreme case when the order of m is 50, efficiency score estimates are again 2% lower over the longer post-reform period, compared to the pre- and initial period. It appears that improvement started in 2008 and continued till 2019, with very minor deterioration during the COVID period, and subsequently. These trends are broadly in line with the literature reviewed and cited before. It appears that the consistency of reforms alongside the second round of reforms significantly impacts efficiencies over longer periods. A deeper inspection is carried out below by observing the trend across three ownerships, i.e., public, private and foreign, like the analysis of the initial impact of reforms.

Some interesting conclusions could be drawn when looking at the estimates of publicly owned banks. Irrespective of the order of m (5, 10 or 25), there does not appear to be any significant change in scores before, and immediate post-reform period as well as during the longer post reforms period (as shown by Figure 4a and Tables 3 and 5). The estimates remained stagnant around 0.71, 0.83 and 0.95 linked to 5, 10 and 25 orders from 2005 to 2023. More importantly, these scores are higher compared to industry averages across the whole period considered in this study. Thus, our findings are different from Rakshit's (2023). The story for privately owned Indian banks is interesting, nonetheless. The estimates contained in Table 5 clearly show that input use efficiency declined for these domestic groups of privately owned banking firms during the more mature post-reform period. By considering the order of m equal to 5, 10 and 25, the average score remained 0.31, 0.46, 0.69 during the pre-reforms period, increasing to 0.37, 0.51 and 0.72 during 1992–2003 and finally changing to 0.48, 0.62 and 0.80 during 2005 to 2023. Broadly speaking, there appears to be a significant decline in efficiency for these domestic groups of firms (around 8% to 12% compared to the pre-reforms period, depending on the order of m). However, the efficiency score of these banking firms is still significantly lower than domestic publicly owned banking firms and thus importantly more efficient in utilising inputs. A significant decline for these group of firms could have been due to intense competition for customers, resources and talent pool from the state-owned banks as well as foreign banks who have witnessed a significant increase in business activities during this period.

Lastly, as before for shorter post-reforms period, foreign-owned Indian banking firms appear to be more efficient in using inputs compared to domestic banks (both public and privately owned) over a longer period, irrespective of the order of m. When compared against the initial impact of reform trends (shown in Figure 4d and Table 3), estimates show improvement in input use efficiency for these groups of banking firms. Hence, the improvement in input use efficiency of the industry during a more mature post-reform period appears to be driven by foreign-owned banking firms in India. Publicly owned banking firms appear to be

less efficient in using inputs during the entire period of almost 40 years and all sorts of reforms appear to have done little in encouraging these firms to improve inputs utilisation, nonetheless. It's fascinating to examine the peculiar situation of public sector banks. Many of these banks assist in mobilising savings in addition to their commercial activities. In addition to lending to priority industries, these banks also provide loans to those that privately held banks steer clear of for business reasons. Therefore, maximising social welfare is important to these banks. Additional arguments have been made in the literature on these entities' preference for certain expenses. These financial companies' managers could choose to increase expenditures by recruiting more staff and boosting spending on benefits and incentives. If this behaviour continues, it may result in a decreased preference for input minimisation, which could either cause efficiency levels to stagnate or worsen over time. In the following subsection, we will test this against Pakistani public sector banks.

Pakistani banking industry

Table 6 contains efficiency estimates using different orders (m = 5, 10, 25 and 50). As stated in the initial reforms period assessment, the input-oriented efficiency score increases as the order of the m increases. The estimates inform an interesting story when using order10 efficiency scores. Compared to earlier initial reform score estimates of 0.76, input distance efficiency scores are reduced to around 0.71, thus evidence of increased input use efficiency (around 5%), indicating a reduced variation in performance (majority of firms performing well against benchmarked firms). There appears to be a general decline in input distance scores since 2008, and one could notice a reversal around 2013. These scores are nonetheless 5% to 6% less compared to the initial post-reforms period average score of 1992 to 2003. Hence, we conclude that input use efficiency improvement that started at the beginning of reforms in the early 1990s continued over the longer post-reforms period. More importantly, irrespective of the order chosen, trends and related conclusions appear to be like above. Efficiency kept improving and then declined slightly in the last two years of the sample period. Irrespective of the order of m chosen, score values are less during 2005–2020, compared to 1992–2003. This could be explained by several factors including persistence with reforms (or at least not reversing) and independence of the central bank in the country, which helped less regulation of the banking industry and improved the business environment over several years.

When firms are divided into three ownership categories and average score statistics are recalculated for each group, some interesting observations can be made. First focusing on m = 10, domestic private banks do not appear to be

performing significantly better than public-owned banks during the more mature post-reform period. Interestingly, a decline in the input distance score of the government-owned banks between 2009 and 2018 is matched by an increase in the subsequent 2 years, keeping the overall trend flat. A comparison to 1992–2003 estimates shows that the declining trend in the input distance score of public sector banks started immediately after reforms in the early 1990s and continued for many years to come. The improvement over the longer post-reform period is substantial for public sector banks. This is an important finding, as these types of banks are not known as input minimisers, given the expense preference of the management in these banks. On the other hand, domestic private banks appear to be experiencing significant fluctuations in their performance over this period, as approximated by their input use efficiency scores, again generating a broadly flat score trend over the longer post-reforms period (2005 to 2020). However, a comparison to 1992–2003 estimates shows that efficiency – broadly speaking – remained in the region of 0.6 s and 0.8 s (with m = 5 and 10) throughout the initial post-reform periods, with fluctuations around this estimate. However, the score increased to the higher end of 0.60 s and 0.70 s between 2005 and 2020, indicating a marginal improvement or at best no further change in input use efficiency, nonetheless. The reforms are expected to make these firms more efficient in inputs utilisation and this flat trend or marginal improvement over a longer period needs further investigation. One of the potential reasons could be that these banks are expected to face tough competition from foreign-owned counterparts. However, since 9/11, most foreign-owned banks have been bought by domestic financial firms or firms from the Middle East which have already developed connections with local Pakistani businesses. Similarly, for privatised banks, adjustment already happened in 1992 when these banks were privatised. Further reduction in employees is difficult given the fact that maintaining of output level to capture market share makes further adjustments very hard.

Foreign-owned banks appear to experience a similar input use efficiency score over the longer post-reforms period, indicating that after significant improvement in the first 10 years of reforms, foreign banks did not further improve their efficiencies and, in fact, except for two/three years of improvement (2011–2013), the trend is generally flat. The efficiency scores of foreign-owned and domestically owned public sector banks appear to be similar (60% on average from 2005 to 2020). A comparison to 1992–2003 estimates shows that efficiency scores of 2005 to 2020 are in fact like those recorded in the last 2/3 years of the initial impact reforms period (2001 to 2003). This result is interesting in the context that several foreign-owned banks have either sold up their operations to Middle Eastern businesses due to the law and order situation or have moved to the Islamic banking model due to increased demand for Islamic banking products in the last 15 years. More importantly, despite these changes, their dominance over domestic private banks remained intact over a longer period. This perhaps could be explained by to supervisor's human and technological resources at their disposal alongside the transfer of technology and business models from the parent banks abroad.

Table 5

Input use efficiency of Indian banking industry

Year	Industry				Domestic publicly owned banks				Domestic privately-owned banks				Foreign-owned banks			
	order5	order10	order25	order50	order5	order10	order25	order50	order5	order10	order25	order50	order5	order10	order25	order50
2005	0.388	0.529	0.730	0.872	0.705	0.828	0.947	0.989	0.409	0.549	0.745	0.886	0.202	0.326	0.551	0.756
2006	0.391	0.529	0.732	0.871	0.722	0.838	0.951	0.989	0.404	0.539	0.737	0.875	0.200	0.322	0.555	0.759
2007	0.401	0.539	0.738	0.876	0.715	0.833	0.948	0.988	0.432	0.568	0.751	0.882	0.205	0.326	0.559	0.768
2008	0.395	0.529	0.727	0.863	0.691	0.826	0.949	0.989	0.462	0.591	0.776	0.904	0.187	0.295	0.514	0.712
2009	0.386	0.528	0.729	0.868	0.702	0.829	0.955	0.996	0.450	0.585	0.769	0.894	0.196	0.321	0.545	0.745
2010	0.378	0.518	0.721	0.863	0.691	0.824	0.949	0.995	0.447	0.579	0.760	0.888	0.198	0.320	0.546	0.747
2011	0.370	0.510	0.715	0.858	0.700	0.829	0.952	0.994	0.464	0.594	0.772	0.898	0.194	0.316	0.543	0.743
2012	0.377	0.519	0.730	0.875	0.696	0.823	0.946	0.990	0.523	0.652	0.819	0.921	0.215	0.344	0.583	0.788
2013	0.368	0.507	0.719	0.869	0.703	0.826	0.947	0.990	0.521	0.645	0.813	0.920	0.209	0.335	0.573	0.780
2014	0.355	0.497	0.712	0.861	0.681	0.811	0.942	0.988	0.507	0.637	0.809	0.918	0.198	0.325	0.562	0.766
2015	0.348	0.489	0.697	0.845	0.692	0.822	0.947	0.990	0.520	0.653	0.823	0.928	0.190	0.311	0.534	0.733
2016	0.339	0.484	0.699	0.849	0.688	0.823	0.948	0.991	0.467	0.607	0.798	0.915	0.193	0.319	0.550	0.749
2017	0.337	0.478	0.690	0.839	0.689	0.820	0.945	0.988	0.484	0.616	0.801	0.917	0.189	0.311	0.537	0.733
2018	0.330	0.476	0.699	0.853	0.717	0.846	0.960	0.994	0.494	0.645	0.835	0.942	0.193	0.320	0.558	0.760
2019	0.329	0.473	0.693	0.848	0.684	0.817	0.950	0.991	0.492	0.641	0.826	0.932	0.197	0.322	0.555	0.757
2020	0.338	0.492	0.720	0.876	0.693	0.831	0.961	0.994	0.485	0.640	0.827	0.933	0.216	0.355	0.604	0.810
2021	0.336	0.490	0.730	0.886	0.757	0.872	0.970	0.996	0.499	0.658	0.864	0.956	0.227	0.369	0.628	0.830
2022	0.337	0.495	0.731	0.886	0.766	0.881	0.974	0.996	0.502	0.667	0.866	0.959	0.227	0.372	0.629	0.829
2023	0.335	0.490	0.722	0.876	0.761	0.877	0.970	0.996	0.519	0.677	0.867	0.958	0.217	0.358	0.610	0.811
Average	0.360	0.504	0.718	0.865	0.708	0.835	0.953	0.992	0.478	0.618	0.803	0.917	0.203	0.330	0.565	0.767

Table 6
Input use efficiency of Pakistani banking industry

Year	Industry				Domestic publicly owned banks				Domestic privately-owned banks				Foreign-owned banks			
	order5	order10	order25	order50	order5	order10	order25	order50	order5	order10	order25	order50	order5	order10	order25	order50
2005	0.541	0.705	0.893	0.976	0.529	0.712	0.928	1.005	0.649	0.805	0.948	0.989	0.452	0.609	0.820	0.948
2006	0.561	0.729	0.912	0.993	0.511	0.696	0.903	0.980	0.617	0.774	0.927	0.981	0.527	0.695	0.900	1.017
2007	0.570	0.734	0.925	1.007	0.516	0.696	0.899	0.975	0.638	0.791	0.939	0.988	0.539	0.702	0.926	1.041
2008	0.546	0.705	0.893	0.977	0.422	0.595	0.833	0.952	0.684	0.823	0.953	0.994	0.506	0.666	0.870	0.975
2009	0.554	0.706	0.889	0.971	0.430	0.599	0.833	0.945	0.700	0.832	0.955	0.996	0.509	0.661	0.861	0.963
2010	0.550	0.702	0.888	0.971	0.464	0.618	0.823	0.939	0.663	0.806	0.945	0.990	0.507	0.663	0.872	0.969
2011	0.534	0.692	0.879	0.965	0.448	0.616	0.838	0.946	0.732	0.871	0.974	0.998	0.456	0.613	0.832	0.951
2012	0.523	0.675	0.867	0.958	0.448	0.611	0.836	0.947	0.709	0.844	0.960	0.993	0.445	0.595	0.814	0.936
2013	0.534	0.689	0.874	0.962	0.456	0.624	0.835	0.946	0.737	0.867	0.973	1.001	0.450	0.604	0.822	0.939
2014	0.542	0.698	0.881	0.963	0.472	0.628	0.841	0.940	0.741	0.872	0.981	1.009	0.450	0.612	0.825	0.939
2015	0.551	0.706	0.884	0.964	0.448	0.623	0.835	0.942	0.697	0.833	0.952	0.987	0.502	0.654	0.855	0.957
2016	0.548	0.706	0.887	0.965	0.447	0.610	0.829	0.943	0.660	0.802	0.936	0.983	0.521	0.686	0.881	0.963
2017	0.555	0.719	0.903	0.979	0.432	0.603	0.834	0.946	0.734	0.872	0.989	1.020	0.494	0.666	0.868	0.961
2018	0.551	0.715	0.896	0.975	0.439	0.612	0.825	0.945	0.743	0.884	0.992	1.017	0.473	0.640	0.853	0.954
2019	0.612	0.768	0.934	0.996	0.523	0.691	0.886	0.968	0.757	0.892	1.004	1.036	0.534	0.696	0.892	0.972
2020	0.588	0.740	0.909	0.979	0.514	0.680	0.883	0.971	0.725	0.852	0.962	0.996	0.506	0.668	0.870	0.964
Average	0.554	0.712	0.895	0.975	0.469	0.638	0.854	0.956	0.703	0.841	0.963	0.999	0.492	0.652	0.860	0.966

Long run input use efficiency comparisons across Indian and Pakistani banking industries

Table 7 contains comparative overall average efficiency score estimates of two countries as well as by three ownerships and pre- and post-reforms periods. Some interesting observations could be made by looking at these estimates. First, broadly speaking, Indian banks' input optimisation efforts appear to be significantly more successful compared to Pakistani banks. The difference in efficiency score is around 0.23. This difference could be easily explained by private sector banks (both domestic private and foreign-owned Indian banks). Interestingly, our estimates do not show any significant difference in input use efficiency estimates of the state-owned banks in both countries. By close inspection of estimates contained in Tables 5 and 6 shows that since 2005, Pakistani public-owned banks have done better than their Indian counterparts. This perhaps is because of fewer observations, as most state-owned banks in Pakistan have been privatised from 1992 to 2004. More importantly, Indian banks were more efficient before reforms and remained so subsequently. The difference in pre-reforms period was 0.33 which reduced to 0.21, a reduction of 0.12. As stated before, the input use efficiency of Indian banks improved by roughly 0.03 after reforms compared to 0.15 for the Pakistani banking industry. In summary, Indian banks maintained their relatively superior use of resources at their disposal during the entire sample period, covering almost four decades, nonetheless.

Table 7
Summary of long run comparison of input use efficiency estimates (m = 10)

Country	Overall	Public	Private	Foreign	Pre-reforms 1985–1991	Post reforms 1992–2020
Pakistan	0.759	0.806	0.809	0.705	0.880	0.730
India	0.526	0.815	0.511	0.314	0.549	0.521

Broadly speaking, reforms reduced heterogeneity in the efficiencies of the Pakistani banks over a longer period, and general level efficiency has improved over the three decades of the post-reforms period (since 1990 onward). This finding is like the Indian banking industry which also witnessed longer-term efficiency gains, even though the initial impact of reforms was not what was expected when these policies were introduced. Regulatory, economic, social, law and order, and the economy could have contributed to these trends for both countries, which are the subject of our forthcoming study.

CONCLUSIONS

There is abundant published literature on the estimation of efficiency after reforms generally, and in the banking industry. However, a significant number of studies could be criticised based on the methods used to estimate efficiency and the relatively short post-reform evaluation periods used. In addition, several cross-country studies included many countries with different regulatory frameworks and economic/social environments. We overcame these issues in this study and used the banking industries of two countries with similar reforms and initiation times, and significant sharing of cultural, social, language and managerial practices. The study investigates inputs use efficiency using the frontier order-m estimation technique for Indian and Pakistani banks over the period 1985–2023, covering pre-, during-, and post-reform in response to substantial changes comprised of deregulation, financial sector openness, privatisation of state-owned banks, and changes in prudential regulation in 1992, and then again in 1998. The study evaluates both the initial and longer-run impact of these reforms on the input use efficiencies of the two countries' banking industries. The most striking conclusion here is that the average Indian and Pakistani commercial bank across all periods consistently operates beyond the efficiency frontier by using fewer inputs than would be expected by a hypothetical bank on the frontier to produce a given level of output. This distance beyond the frontier decreases as the order of (m) increases, with order 50 efficiency ratings appearing quite close to (but not inside) the frontier for the average Indian and Pakistani bank.

The finding suggests that a response to the changes observed in the regulatory, financial and economic environment is less straightforward to understand. The estimates of order-m efficiency score show no initial significant improvement in the Indian banking industry from 1992 to 2003. Even when different orders of (m) are imposed upon the efficiency model, the different estimates for the order-m estimator show no significant impact on the country. For Pakistani banks, however, the evidence appears that input use efficiency had improved significantly in the initial post-reforms period for the entire industry as well as public sector and foreign-owned banks. In the subsequent years (2005–2023), estimates of efficiency scores either remained broadly like 1992–2003 estimates or further improved for both countries. In comparative terms, Indian banks were already significantly more efficient in their utilisation of resources compared to Pakistani banks before reforms and remained so after. Making a clear conclusion from these mixed results of the initial impact for the two countries is difficult when it comes to the response of banks to reforms, and so the initial effect of reforms on an already efficient Indian banking sector appears to be unclear. However, the later evidence shows improvement in efficiency over a longer

period (since 2000 in particular). Interestingly, the case for reforms regarding the Pakistani banking industry is clear, as it has witnessed improvement in input use efficiency (both initial and longer run).

In terms of a comparison of the industries in these two countries, Indian banks are comparatively better in utilising their inputs compared to Pakistani banks during pre- and post-reform periods. However, the gap in efficiencies has reduced over time. A comparison of order-m efficiency levels between three types of Indian and Pakistani banks is also made – those with public, private and foreign ownership. For both India and Pakistan, the results suggest that foreign and private sector banks were consistently more efficient compared to publicly owned banks between 1985 and 2003. Public sector Pakistani banks managed to reduce their inefficiencies significantly after reforms and, at the end of the century, the inefficiency level in input usage almost reached to same level as privately-owned banks. Pakistani public sector banks continued their journey of the first 10 years of the post-reforms period and reduced the inefficiency further in the next 15 years. Indian privately owned and foreign banks appeared to be twice as efficient in using inputs from 1990 to 2003 compared to similarly owned Pakistani banks. There is evidence that this gap in input use efficiency persisted in the next 15 years, nonetheless.

As previously said, this study makes a substantial contribution to the body of knowledge regarding how changes affect the operational performance and decision-making of firms. Our methodology solves several of the limitations of previous studies, including the lower number of enterprises and a good number of inputs and outputs that present dimensionality issues in frontier efficiency modelling. This problem is resolved via a partial frontier estimate. A longer time frame resolves the problem of performance improvements occurring instantly because of advantageous business conditions rather than reforms in and of themselves. Furthermore, the findings and conclusions of this study are extremely important and valuable for policymakers and contribute to the wider academic literature on the long-term impact of reforms on performance in the banking industry. Not only did reforms help private sector and foreign-owned banks improve efficiency, but they also helped publicly owned banks improve performance. It appears that governments in these countries not only introduced reforms, first in the early 1990s and again later in the decade but also persisted with their agendas over the long term, which helped improve performance. A lot of developing countries with similar economic, social, regulatory and financial settings could therefore benefit from the findings of this study.

The policy implications of the study are two. First, a country that has already well well-functioning financial market and a relatively better business environment will benefit from reforms, but more benefits are attached to those whose banking sector is underdeveloped. Second, persistence with reforms is important over a longer time. Not doing so could reverse the gains in a short period. Third, foreign ownership of banks is beneficial as our study clearly shows that foreign banks use inputs more efficiently and thus benefits for the consumer could be substantial (i.e., better service provision and higher competition with local banks). The study cannot control the macroeconomic environmental factors in estimation which may be conducted in a multivariate regression framework in future studies.

NOTES

1. Bank and financial institutions play a key role in the economic acceleration of any country (Podder & Mamun, 2004) and hence a broader target for reforms.
2. Both countries were part of the British Empire until India was recognised as a republic in 1950. It has the fastest-growing industries including IT, textiles and mining. Banking has also become an emerging industry in the modern era. Pakistan, the second largest country in the sub-continent, achieved its independence from the British Empire at the same time as India, but the country's past had been fractious for a variety of reasons. This instability has affected the country's financial, social and economic development significantly.

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REFERENCES

Ahmad, S. R., & Khan, M. N. (2021). Efficiency measurement of the Indian banking industry: An empirical comparative analysis. *International Journal of Financial Research, 12*(4), 135–145. https://doi.org/10.5430/ijfr.v12n4p135

Ahmad, S., & Burki, A. A. (2016). Banking deregulation and allocative efficiency in Pakistan. *Applied Economics, 48*(13), 1182–1196. https://doi.org/10.1080/00036846.2015.1096001

Alam, I. M. S. (2001). A nonparametric approach for assessing productivity dynamics of large US banks. *Journal of Money, Credit and Banking, 33*(1), 121–139. https://doi.org/10.2307/2673875

Ali, U., Hussain, K., & Sheikh, R. (2023). Performance analysis of Islamic banking in Pakistan using DEA technical efficiency and Maqasid-e-Shariah Index. *Journal of Islamic Business and Management, 13*(1), 56–70. https://doi.org/10.26501/jibm/2023.1301-004

Ataullah, A., Cockerill, T., & Le, H. (2004). Financial liberalization and bank efficiency: A comparative analysis of India and Pakistan. *Applied Economics, 36*(17), 1915–1924. https://doi.org/10.1080/000368404200068638

Badunenko, O., & Kumbhakar, S. C. (2017). Economies of scale, technical change and persistent and time-varying cost efficiency in Indian banking: Do ownership, regulation and heterogeneity matter? *European Journal of Operational Research, 260*(2), 789–803. https://doi.org/10.1016/j.ejor.2017.01.025

Battese, G. E., Heshmanti, A., & Hjalmarsson, L. (2000). Efficiency of labour used in the Swedish banking industry: A stochastic frontier approach. *Empirical Economics, 25*, 623–640. https://doi.org/10.1007/s001810000037

Bauer, P. W., Berger, A. N., & Humphrey, D. B. (1993). Efficiency and productivity growth in US banking. *The Measurement of Productive Efficiency: Techniques and Applications*, *1*, 386–413. https://doi.org/10.1093/oso/9780195072181.003.0016

Berg, S. A., Førsund, F. R., & Jansen, E. S. (1992). Malmquist indices of productivity growth during the deregulation of Norwegian banking, 1980-89. *The Scandinavian Journal of Economics, 94*, S211–S228. https://doi.org/10.2307/3440261

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research, 98*(2), 175–212. https://doi.org/10.1016/S0377-2217(96)00342-6

Berger, A. N., & Mester, L. J. (2003). Explaining the dramatic changes in performance of US banks: technological change, deregulation, and dynamic changes in competition. *Journal of Financial Intermediation*, *12*(1), 57–95. https://doi.org/10.1016/S1042-9573(02)00006-2

Berger, A. N., & Mester, L. J. (2001). Inside the black box: What explains differences in the efficiencies of financial institutions? *International Library of Critical Writings in Economics*, *133*, 220–272.

Berger, A. N., & Mester, L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking & Finance*, *21*(7), 895–947. https://doi.org/10.1016/S0378-4266(97)00010-1

Bhattacharyya, A., & Pal, S. (2013). Financial reforms and technical efficiency in Indian commercial banking: A generalized stochastic frontier analysis. *Review of Financial Economics, 22*(3), 109–117. https://doi.org/10.1016/j.rfe.2013.04.002

Bhattacharyya, A., Lovell, C. K., & Sahay, P. (1997). The impact of liberalization on the productive efficiency of Indian commercial banks. *European Journal of Operational Research, 98*(2), 332–345. https://doi.org/10.1016/S0377-2217(96)00351-7

Bonin, J. P., Hansen, I., & Wachtel, W. (2005). Bank performance, ownership and efficiency in transition economies. *Journal of Banking and Finance, 29*, 31–53. https://doi.org/10.1016/j.jbankfin.2004.06.015

Canhoto, A., & Dermine, J. (2003). A note on banking efficiency in Portugal, new vs. old banks. *Journal of Banking and Finance, 27*, 2087–2098. https://doi.org/10.1016/S0378-4266(02)00316-3

Casu, B., Ferrari, A., & Zhao, T. (2013). Regulatory reform and productivity change in Indian banking. *Review of Economics and Statistics, 95*(3), 1066–1077. https://doi.org/10.1162/REST_a_00298

Cazals, C., Florens, J. P., & Simar, L. (2002). Nonparametric frontier estimation: A robust approach. *Journal of Econometrics, 106*(1), 1–25. https://doi.org/10.1016/S0304-4076(01)00080-X

Chong, A., & López-de-Silanes, F. (2005). The truth about privatization in Latin America. In A. Chong, & F. López-de-Silanes (Eds.), *Privatization in Latin America: Myths and reality* (pp. 1–66). Stanford University Press and The World Bank. https://doi.org/10.1596/978-0-8213-5882-5

Clarke, G. R., Cull, R., & Shirley, M. M. (2005). Bank privatization in developing countries: A summary of lessons and findings. *Journal of Banking and Finance, 29*(8–9), 1905–1930. https://doi.org/10.1016/j.jbankfin.2005.03.006

Daouia, A. (2003). Nonparametric analysis of frontier production functions and efficiency measurement using nonstandard conditional quantiles. Unpublished doctoral dissertation, Groupe de Recherche en Economie Mathématique et Quantititative, Université des Sciences Sociales, Toulouse I, et Laboratoire de Statistique et Probabilités, Université Paul Sabatier, Toulouse III, France.

Daouia, A., & Simar, L. (2007). Nonparametric efficiency analysis: A multivariate conditional quantile approach. *Journal of Econometrics, 140*(2), 375–400. https://doi.org/10.1016/j.jeconom.2006.07.002

Das, A., & Ghosh, S. (2006). Financial deregulation and efficiency: An empirical analysis of Indian banks during the post reform period. *Review of Financial Economics, 15*(3), 193–221. https://doi.org/10.1016/j.rfe.2005.06.002

Das, A., & Kumbhakar, S. C. (2012). Productivity and efficiency dynamics in Indian banking: An input distance function approach incorporating quality of inputs and outputs. *Journal of Applied Econometrics, 27*(2), 205–234. https://doi.org/10.1002/jae.1183

Deprins, D., Simar, L., & Tulkens, H. (1984). Measuring labor efficiency in post offices. In M. Marc- hand, P. Pestieau, & H. Tulkens (eds.), *The performance of public enterprises: Concepts and measurements* (pp. 285–309). Amsterdam: North Holland.

Di Patti, E. B., & Hardy, D. C. (2005). Financial sector liberalization, bank privatization, and efficiency: Evidence from Pakistan. *Journal of Banking & Finance*, *29*(8–9), 2381–2406. https://doi.org/10.1016/j.jbankfin.2005.03.019

Färe, R., Grosskopf, S., Logan, J., & Lovell, C. K. (1985). Measuring efficiency in production: With an application to electric utilities. In *Managerial issues in productivity analysis* (pp. 185–214). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-015-7721-2

Garg, S., & Gupta, P. K. (2020). Input-output model selection in DEA evaluation framework for efficiency optimization of Indian banks. *Productivity, 61*(1), 34–47. https://doi.org/10.32381/PROD.2020.61.01.4

Gilbert, R. A., & Wilson, P. W. (1998). Effects of deregulation on the productivity of Korean banks, *Journal of Economics and Business. 50*, 133–155. https://doi.org/10.1016/S0148-6195(97)00074-X

Grossman, S. J., & Hart, O. D. (1986). The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy, 94*(4), 691–719. https://doi.org/10.1086/261404

Gulati, R. (2022). Global and local banking crises and risk-adjusted efficiency of Indian banks: Are the impacts perspective-dependent? *The Quarterly Review of Economics and Finance, 84*, 23–39. https://doi.org/10.1016/j.qref.2022.01.004

Heshmanti, A. (2001). Labour demand and efficiency in Swedish savings banks. *Applied Financial Economics, 11*, 423–433. https://doi.org/10.1080/096031001300313983

Howcroft, B., & Ataullah, A. (2006). Total factor productivity change: An examination of the commercial banking industry in India and Pakistan. *The Service Industries Journal, 26*(2), 189–202. https://doi.org/10.1080/02642060500369305

Humphrey, D. B. (1993). Cost and technical change: Effects from bank deregulation. *Journal of Productivity Analysis*, *4*(1), 9–34. https://doi.org/10.1007/BF01073463

Humphrey, D. B., & Pulley, L. B. (1997). Banks' responses to deregulation: Profits, technology, and efficiency. *Journal of Money, Credit, and Banking, 29*(1), 73–93. https://doi.org/10.2307/2953687

Iimi, A. (2004). Banking sector reforms in Pakistan: economies of scale and scope, and cost complementarities. *Journal of Asian Economics, 15*(3), 507–528. https://doi.org/10.1016/j.asieco.2004.03.004

Jaffry, S., Ghulam, Y., & Cox, J. (2013). Trends in efficiency in response to regulatory reforms: The case of Indian and Pakistani commercial banks. *European Journal of Operational Research, 226*(1), 122–131. https://doi.org/10.1016/j.ejor.2012.11.002

Jaffry, S., Ghulam, Y., Pascoe, S., & Cox, J. (2007). Regulatory changes and productivity of the banking sector in the Indian sub-continent. *Journal of Asian Economics, 18*(3), 415–438. https://doi.org/10.1016/j.asieco.2007.02.010

Jomo, K. S. (2008). A critical review of the evolving privatization debate. In G. Roland (Ed.), *Privatization: Successes and failures* (pp. 199–212). Berlin, Germany: De Gruytel Brill. https://doi.org/10.7312/rola14160-009

Kale, S. (2022). Productivity growth of Indian banking sector: A comparative analysis of pre-and post-global financial crisis. *Journal of Public Affairs, 22*(1), e2282. https://doi.org/10.1002/pa.2282

Kumbhakar, S. C., & Sarkar, S. (2003). Deregulation, ownership, and productivity growth in the banking industry: Evidence from India. *Journal of Money, Credit and Banking, 53*(3), 403–424. https://doi.org/10.1353/mcb.2003.0020

Kumbhakar, S. C., Lozano-Vivas, A., Knox-Lovell, C. A., & Hasan, I. (2001). The effects of deregulation on the performance of financial institutions: The case of Spanish savings banks. *Journal of Money, Credit and Banking, 33*(1), 101–120. https://doi.org/10.2307/2673874

Laffont, J. J., Tirol, J., & Idei, Gremaq, and Ceras. (1993). Cartelization by regulation. *Journal of Regulatory Economics, 5*(2), 111–130. https://doi.org/10.1007/BF01065361

Leibenstein, H. (1966). Allocative efficiency vs."X-efficiency". T*he American Economic Review, 56*(3), 392–415.

Leightner, J. E., & Lovell, C. K. (1998). The impact of financial liberalization on the performance of Thai banks. *Journal of Economics and Business, 50*(2), 115–131. https://doi.org/10.1016/S0148-6195(97)00073-8

Mendes, V., & Rebelo, J. (1999). Productive efficiency, technological change and productivity in Portuguese banking. *Applied Financial Economics, 9*(5), 513–521. https://doi.org/10.1080/096031099332177

OECD. (2009). Privatisation in the 21st century: Recent experiences of OECD countries report on good practices, January 2009. OECD.

Podder, J., & Mamun, A. A. (2004). Loan loss provisioning system in Bangladesh banking: A critical analysis. *Managerial Auditing Journal, 19*(6), 729–740. https://doi.org/10.1108/02686900410543859

Rakshit, B. (2023). Assessing the effects of cost, revenue and profit efficiency on bank performance: Empirical evidence from Indian banking. *International Journal of Organizational Analysis, 31*(5), 1867–1898. https://doi.org/10.1108/IJOA-06-2021-2802

Ray, S. C., & Das, A. (2010). Distribution of cost and profit efficiency: Evidence from Indian banking. *European Journal of Operational Research, 201*(1), 297–307. https://doi.org/10.1016/j.ejor.2009.02.030

Roland, G. (Ed.). (2008). Privatization*: Successes and failures*. Columbia University Press. https://doi.org/10.7312/rola14160

Saha, A., & Ravisankar, T. S. (2000). Rating of Indian commercial banks: a DEA approach. *European Journal of Operational Research*, *124*(1), 187–203. https://doi.org/10.1016/S0377-2217(99)00167-8

Sanyal, P., & Shankar, R. (2011). Ownership, competition, and bank productivity: An analysis of Indian banking in the post-reform period. *International Review of Economics and Finance, 20*(2), 225–247. https://doi.org/10.1016/j.iref.2010.05.002

Sathye, M. (2003). Efficiency of banks in a developing economy: The case of India. *European Journal of Operational Research, 148*(3), 662–671. https://doi.org/10.1016/S0377-2217(02)00471-X

Sensarma, R. (2006). Are foreign banks always the best? Comparison of state-owned, private and foreign banks in India. *Economic Modelling, 23*(4), 717–735. https://doi.org/10.1016/j.econmod.2006.04.002

Shahzad, A., Mahmood, T., & Shahzad, M. (2021). A comparative study of banking sectors of Pakistan and India: An application of data envelopment analysis. *Lahore Journal of Business, 9*(2), 41–78. https://doi.org/10.35536/ljb.2021.v9.i2.a3

Shanmugam, K. R., & Das, A. (2004). Efficiency of Indian commercial banks during the reform period. *Applied Financial Economics, 14*(9), 681–686. https://doi.org/10.1080/0960310042000233458

Shephard, R. W. (1970). *Theory of cost and production functions*. Princeton University Press.

Shimizu, S. (2010). The state of the Indian banking sector and its role in India's high growth. *RIM Pacific Business and Industries, 10*(36), 1–35.

Shukla, S. S., & Lalwani, S. (2020). Efficiency analysis of Indian private sector banks: Data envelopment technique. *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*, 8(4), 1947–1957.

Singh, P. K., & Thaker, K. (2020). Profit efficiency and determinants of Indian banks; A truncated bootstrap and data envelopment analysis. *Cogent Economics and Finance, 8*(1), 1724242. https://doi.org/10.1080/23322039.2020.1724242

Smith, P. (1997). Model misspecification in data envelopment analysis. Annals of Operations Research, 73(0), 233–252. https://doi.org/10.1023/A:1018981212364

Tzeremes, N. G. (2015). Efficiency dynamics in Indian banking: A conditional directional distance approach. *European Journal of Operational Research, 240*(3), 807–818. https://doi.org/10.1016/j.ejor.2014.07.029

Vickers, J., & Yarrow, G. (1991). Economic perspectives on privatization. *Journal of Economic Perspectives, 5*(2), 111–132. https://doi.org/10.1257/jep.5.2.111

Wheelock, D. C., & Wilson, P. W. (1999). Technical progress, inefficiency, and productivity change in US banking, 1984–1993. *Journal of Money, Credit, and Banking, 31*(2), 212–234. https://doi.org/10.2307/2601230

Wheelock, D. C., & Wilson, P. W. (2003). *Robust nonparametric estimation of efficiency and technical change in US commercial banking*. Federal Reserve Bank of St. Louis Working Paper Series, (2003-037). https://doi.org/10.20955/wp.2003.037

Wheelock, D. C., & Wilson, P. W. (2004). Trends in the efficiency of Federal Reserve check processing operations. *Federal Reserve Bank of St. Louis Review, 86*(September/October 2004). https://doi.org/10.20955/r.86.7-20

Wheelock, D. C., & Wilson, P. W. (2008). Non-parametric, unconditional quantile estimation for efficiency analysis with an application to Federal Reserve check processing operations. *Journal of Econometrics, 145*(1–2), 209–225. https://doi.org/10.1016/j.jeconom.2008.05.007

Wheelock, D. C., & Wilson, P. W. (2009). Robust nonparametric quantile estimation of efficiency and productivity change in US commercial banking, 1985–2004. *Journal of Business and Economic Statistics, 27*(3), 354–368. https://doi.org/10.1198/jbes.2009.06145

Williamson, O. E. (1981). The economics of organization: The transaction cost approach. *American Journal of Sociology, 87*(3), 548–577. https://doi.org/10.1086/227496

Zaim, O. (1995). The effect of financial liberalization on the efficiency of Turkish commercial banks. *Applied Financial Economics, 5*(4), 257–264. https://doi.org/10.1080/758536876

Zhu, N., Shah, W. U. H., Kamal, M. A., & Yasmeen, R. (2021). Efficiency and productivity analysis of Pakistan's banking industry: A DEA approach. *International Journal of Finance and Economics, 26*(4), 6362–6374. https://doi.org/10.1002/ijfe.2123